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NAVAL AIR DEVELOPMENT CENTER

NADC
Tech. Info.

Advanced System Concepts For Navy Technological Projections III

Submitted To:
Naval Air Systems Command

23 March 1978

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ADVANCED SYSTEM CONCEPTS

Oxygen Enriched Breathing Air Supply System

Selectively Permeable Membrane Oxygen Separation System

Covert Detection of Downed Aircrews Utilizing the Chemiluminescent Principle in the Infrared Spectrum

Helicopter Pyrotechnic Emergency Rotor Torque

Expendable Module, Multiple Store Suspension

RPVs (Remotely Piloted Vehicles) - Ship Interface

T-2 Variable—Stability Emergency—Operations Trainer Airplane; An In-Flight, Real-Environment Training Simulator

Air-to-Subsurface Missile Systems

Automatic Shipboard Landing System for Helicopter and VTOL Aircraft

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Oxygen Enriched Breathing Air Supply System

Concept: This concept is an oxygen generating system for use in low performance aircraft which normally operate below 35,000 feet altitude. This concept is based on the currently available molecular sieve oxygen generation systems used in industry. The breathing air supplied to the crew is enriched with oxygen. This enrichment follows the requirements of diluter-demand schedules. No attempt is made to generate 100% oxygen.

New Capabilities: The size, weight, power consumption, and cost of this type of system are considerably lower than those of 100% oxygen generators. System reliability is high due to the simplicity of the design.

Potential Operational Advantages: Fewer logistics problems will be encountered than with liquid oxygen systems. The safety hazards of liquid oxygen and high pressure oxygen will be avoided. No aircraft utilities other than electrical power and engine bleed air are required. Contamination of the breathing gas is less likely than with diluter-demand systems.

Critical Technologies: Complete studies of possible contaminants which may pass through the system have not been made. It is known that some Argon (2 or 3 percent) will be present. There is no reason to think that this concentration will be harmful; there is evidence that it may be beneficial, but this fact must be shown. A breadboard model of a molecular sieve oxygen generation system will be developed to demonstrate the feasibility of the concept and to investigate potential contaminant problems.

Time Ready for Advanced Development: Estimated to be 18 months.

Estimated Funding Required: $200K

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Selectively Permeable Membrane Oxygen Separation System

Concept: This concept has been used successfully to separate carbon dioxide and water vapor from exhaled gases. The closed loop oxygen generation system developed for the Navy by General Electric uses this technique in the rebreather. The potential to separate nitrogen from oxygen has been demonstrated. The selectively permeable membrane acts as if it were a "fine mesh screen".

New Capabilities: As a nitrogen eliminator, this concept would eliminate the need for purging with the consequent loss of oxygen. This concept might also be useful for oxygen generation or concentration.

Potential Operational Advantages: The size, weight, and power consumption of the oxygen generation system would be reduced since purging consumes half the oxygen generated in present systems. The complexity of the purging equipment would be eliminated, thus increasing system reliability and reducing maintenance requirements.

Critical Technologies: While selectively permeable membranes have been used for carbon dioxide removal, there is less experience with nitrogen removal. A suitable membrane material would require further development.

Time Ready for Advanced Development: Two years is estimated.

Estimated Funding Required: $250K

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Covert Detection of Downed Aircrews Utilizing the Chemiluminescent Principle in the Infrared Spectrum

Concept: Utilization of the Chemiluminescent Principle (visible light spectrum), for detection of downed aircrews, has been proven feasible and has several distinct advantages over normal signal/lighting devices. These devices use fluorescents combined with an oxygen source to produce visible light. The use of this same principle appears feasible for production of light in the infrared spectrum to aid covert night operations.

New Capabilities: A means of night location/identification of downed aircrews, which will be extremely reliable for use during covert operations or when in hostile territory.

Potential Operational Advantages: An infrared chemiluminescent device would not only improve detection and retrieval possibility, but would be more economical, reliable, and provide longer signal duration than the present detection aids.

Critical Technologies: While production of light in the visible range, using the chemiluminescent principle, has proven feasible; to date, a suitable infrared fluorescent producing sufficient emission and having an acceptable shelf life, has not been identified.

Time Ready for Advanced Development: Estimated to be two years

Estimated Funding Required: $150K

Helicopter Pyrotechnic Emergency Rotor Torque

Concept: A concept is proposed that cartridge actuated devices be installed at the rotor blade tips of conventional helicopters or autogyros to serve as an instantaneous source of auxiliary power which could be actuated on demand to drive the main or tail rotors for a relatively short period of time. An H_2O_2 tip propulsion booster was tried on the HRS2. An H_2O_2 generator at the hub weighed 67 lbs dry. H_2O_2 was piped to the rocket motors at blade tip. The tip rocket motors weighed 1 lb each. They generated approximately 120 H.P. - about a 20% increase in power at sea level. Each motor produced about 40 lb of thrust. 300 lbs of fuel gave 6 minutes operation at full power. Project proposed to determine whether a small self-contained rocket at rotor tip is practical to supply emergency power.

New Capabilities: This instantaneous power source could provide the short duration lift or control necessary to allow vertical takeoff of an autogyro or emergency landing of a helo or autogyro.

Potential Operational Advantages: Emergency recovery of helicopters suffering from loss of drive to either rotor. Vertical lift-off of an autogyro for transition to powered horizontal flight.

Critical Technologies: Development of a cartridge actuated device to produce a suitable thrust and duration within a restrictive weight limit.

Time Ready for Advanced Development: 3 years

Estimated Funding Required:

FY1 - $50K
1. Literature Research
2. Feasibility Study
3. Preliminary System Design

FY2 - $100K
1. Preliminary Pyrotechnic System Design
2. Design and Test of Hardware Components
3. Select Prototype Helicopter

FY3 - $150K
1. Design Integration Test Plans
2. Hardware Integration and Continued Development
3. Aircraft Installation and Modification
4. Preliminary Tests

Expendable Module, Multiple Store Suspension

Concept: The concept visualizes 2 to 4 stores (weapons) structurally bolted directly to a simple, modular-configured beam element through existing threaded lug wells. The beam attaches to newest aircraft parent racks, and will also conform with flush-mounted modular store arrangement concepts currently being studied by DOD. No linkage is used, the store separation being initiated by either explosive shaped-charge severance of the local beam attachments or the bolts, or by simple, pyrotechnic bolt release elements. The beam is jettisoned after stores have separated.

New Capabilities: (a) Preloaded weapons modules in an "all-up" ready mode, (b) cost-effective elimination of rack mechanism by use of controlled explosive means, (c) higher weapon load with lower dead weight of suspension system, (d) aerodynamically clean flight profile on mission return, (e) elimination of equipment maintenance by single-use, jettisonable device.

Potential Operational Advantages: (a) Notable reduction in aircraft rearming time by elimination of virtually all preflight loading details, (b) improved reliability by deletion of mechanism and use of simple pyrotechnic separation means, (c) better mission range by virtue of lower total weight vs. loaded MER, (d) clean bolt-on store profile eliminates protuberances, gives lower total drag to target for better mission speed and range, (e) jettison of expended beam restores clean aircraft maneuverability, speed, range, etc., (f) complete elimination of cleaning, repair or maintenance saves assigned manpower, vacates armory and shop spaces, and shortens the total times required for a given operational mission capability, (g) one-shot, throwaway design achieves outstanding financial savings by complete elimination (LSMT, OLSP, MEA, etc. documentation).

Critical Technologies: Minor risk areas include shaped-charge pyrotechnic structural separation capability data and feasibility studies with various structural metals or plastics, material thicknesses, explosive charge weights, controllability and service environment. Modular design aerodynamics characteristics are available from "Conformal Carriage" prior work.

Time Ready for Advanced Development: 9 months

Estimated Funding Required: $50K - 9 months
Extended advanced development $150K - 2 years

RPVs (Remotely Piloted Vehicles) - Ship Interface

Concept: Use of RPVs to replace and/or supplement ship-based manned aircraft for various missions, such as communications relay, ocean/ground surveillance, tactical reconnaissance, strike, decoy, and other AEW, ASW and target applications.

New Capabilities: Airborne operations under high-risk conditions where potential loss of aircrew or manned airplane is not warranted.

Potential Operational Advantages: Navy usage of RPVs is directly associated with the sea-going environment. Within that context, interest in RPVs for tactical applications would most likely stem from the following considerations:

a. The potential for conducting flight operations under conditions too severe for manned aircraft, i.e., poor weather or high sea states, expending the vehicle, if warranted, without jeopardizing an aircrew.

b. The ever-increasing effectiveness of enemy air defenses, particularly in the vicinity of targets of greatest interest, with consequent increase in attrition to levels unacceptable for manned aircraft.

c. The ever-increasing costs of manned aircraft and of training and maintaining proficiency in aircrews.

d. The performance, simplicity and cost advantages of vehicles unconstrained by aircrew provisions and man-rating requirements.

Critical Technologies: The usefulness of RPVs versus manned aircraft must be assessed by trade-off analyses in specific mission situations. For Navy usage, however, it is more immediately important to explore the potential of the RPV concept in the sea-going environment, clearly identifying the problems of shipboard operations and either resolving those problems or specifying the technological development necessary for their solution. The limitations of shipboard launch and recovery of the RPV and other aspects of the ship/RPV interface have not been defined. It is proposed that the interface problems be addressed by a two-phase empirical test and demonstration program, utilizing an existing aerial target, modified as necessary, as the test vehicle.

Time Ready for Advanced Development: The first phase is an engineering investigation of the changes required in an existing target vehicle to match the shipboard operations criteria. The second phase is an "advanced development" test and demonstration program.

Estimated Funding Required: First phase - $125K, 3 man-years
The estimated cost of the second phase is indeterminate, pending some indication of the results of the first phase.

T-2 Variable—Stability Emergency—Operations Trainer Airplane
An In-Flight, Real-Environment Training Simulator

Concept: This concept promises a feasibile and practicable means of providing the Navy with the ultimate in in-flight emergency operations training. Through both external and internal modification an extremely wide range of stability and control characteristics about all axis can be realized, i.e., the flying qualities can be changed at will (via the rear-seated safety/command pilot). External modifications consist of variable drag devices mounted at each wing tip and side-force vanes mounted mid-span on each wing. Internal modifications consist of (1) conversion of the front cockpit to a fly-by-wire, variable-controller-feel, interchangeable instrument panel student pilot station; (2) installation of a master command control panel for the rear cockpit (retaining original mechanical flight control system functions) safety/command pilot station; (3) installation of a digital (rapid-programmable) variable stability control system; (4) installation of 6-axis aircraft motion instrumentation; and (5) replacement of existing control surface actuators with quick-response actuators.

All types of control system failures (including engine controls as well as primary and secondary flight controls) could be simulated safely through in-flight mode selection by the safety/command pilot, thus providing the student with a natural appearing failure as well as with an aircraft which will respond, in a degraded manner, in accordance with the particular failure commanded. The safety pilot also serves to "dump" the variable - stability system and return the airplane to its basic flying characteristics immediately for any cause which may develop throughout training flights. In addition to simulating non-flight control system failures, this special trainer can realistically simulate such situations as:

a. Control surface hard-over failures (rudder, elevator, aileron, etc.; plus secondary control surfaces as well).

b. Approach power compensator failures.

c. Engine-out failures.

d. Partial or complete stability augmentation failures for any combination of axis channels.

e. Hydraulic failures affecting actuator operation.

f. Trim system malfunctions, etc.

It should be noted that the Naval Research Advisory Committee has expressed interest in this subject.

New Capabilities:

a. Full-spectrum, real-environment emergency operations flight training.

b. Can simulate failure modes and consequent flight problems associated with sub-systems whether under development or proposed for development.

c. Full spectrum, real environment, flyable trainer which could simulate many types of naval aircraft for normal flight training.

Potential Operational Advantages: Improvement of flight safety record throughout the greater portion of full operational envelope.

Critical Technologies: With the one possible exception of the digital portion of the variable-stability control system, this development can be accomplished well within the current states of all technologies required.

Time Ready for Advanced Development: Advanced development could begin immediately.

Estimated Funding Required:

FY1 - $1.60M - Preliminary design and wind tunnel test of longitudinal variable - stability, fabrication and installation

FY2 - $1.65M - Lateral-directional; detailed design engineering fabrication, system calibration flight testing and final engineering certification.

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Air-to-Subsurface Missile Systems

(C) Concept: Air-to-subsurface missile system comprising, in combination, a directional sonobuoy (DICASS) and an acoustic homing torpedo (MK 46 modified) which is launched from an aircraft into the water at a position corresponding to the last target fix obtained from underwater detection and localization sonobuoys. Submarine detection and weapon position data are displayed at the Tactical Coordinator (TACO) station in the aircraft or other convenient platform. The sonobuoy, having relatively long detection range (5000 yds) compared to the torpedo (1000 yds) provides acoustic data to the aircraft and relays steering information from the TACO station to the torpedo. The torpedo is thus steered to target intersection on the TACO display. When the torpedo comes within its own acquisition range, 1000 yds, it begins to "home" on its own. The sonobuoy-torpedo package can be used to provide a stand-off range by coupling it to a small cruise missile designed to carry it.

(U) New Capabilities: Increase in the probability of target acquisition by an air-to-subsurface weapon against high speed submarine targets. This is achieved by a low frequency active sonobuoy which is less susceptible to the effect of submarine coatings. The addition of a delivery vehicle provides a stand-off capability that can be used against submarines armed with sub-to-air missiles.

(C) Potential Operational Advantages: The system provides a significant increase to the capability of antisubmarine weapons which can be launched from conventional aircraft, guided missiles, or surface vessels to a position near a target fix. Provided is an intermediate long range target acquisition for guiding the short range torpedo until it comes within terminal acquisition even under conditions when coatings have reduced the detection range of the high frequency torpedo sonar. This system should reduce torpedo running time and increase its effectiveness against high speed targets. This method of increasing detection range should allow more destructive loads to be added to the MK 46 package.

(U) Critical Technologies: Risk area involves the communications link between the sonobuoy and the torpedo. Either an acoustic or wire link can be employed with the lower risk approach being wire-guided. A brief standby mode is required for the torpedo until target position is determined and steering guidance is relayed.

(U) Time Ready for Advanced Development: 18 months fabrication of feasibility models of sonobuoy-torpedo package followed by 6 months of debugging and testing.

(U) Estimated Funding Required: Funding does not include missile

FY-74 - $750K
FY-75 - $2,400K
FY-76 - $5,000K
FY-77 - $500K

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DECLASSIFY ON 31 DECEMBER 1979

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Automatic Shipboard Landing System for Helicopter and VTOL Aircraft

Concept: A system using an airborne digital computer, airborne transceiver, airborne flight director/displays, autopilot coupler, and ship-based landing aids (radar transponder, optical link, precision DME microwave scanning beam antenna, etc.), and deck securing equipment for helicopters.

New Capabilities: All-weather landing capability and flight safety for landing on ships such as DE, LPD, LPH, etc.

Potential Operational Advantages: Combat operations under conditions of rough seas, poor visibility and IFR conditions and landing capability under conditions of pilot fatigue, injury or vehicle damage.

Critical Technologies: Terminal sensor accuracies of ± 2 feet RMS may be required, and operation in high sea states may require ship motion prediction. Signal attenuation in heavy fog and rainfall will reduce guidance effectiveness.

Time Ready for Advanced Development: 2 years

Estimated Funding Required:

FY-74 $150K
FY-75 $300K

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